NAVIGATION TAGS

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DESCRIPTION

The invention relates to a method, a system and a
computer program product for navigating within a
10   navigation area, wherein a plurality of navigation tags
has been mounted at predetermined positions within the
navigation area.

In several situations of modern life, humans find
15   themselves encountered with the problem of quickly
negotiating their way in complex-structured environments
such as huge buildings or densely cropped cities. The
same holds for the automatic guiding of machines. Apart
from traditional approaches for navigation such as
20   printed maps, verbal directions, signs or colour-coded
lines painted on the walls or floors of large buildings,
radio-based systems have gained recent industrial
interest. Among these systems, especially the satellite-
based systems such as the Global Positioning System (and
25   the future Galileo system) can be deployed to provide
users with position information and, in combination with
dedicated navigation devices, also with directions
towards a desired target.

30   However, satellite-based systems in general break down in
indoor environments, because the line-of-sight connection
to the satellite transmitters is heavily attenuated by
concrete ceilings. Furthermore, the spatial resolution of

these positioning systems may not be sufficient for
navigation in small-scale scenarios.

United States patent US 6,049,745 discloses a different
5   approach for navigating automatic guided vehicles (AGVs)
through a workplace scenario. A guidance apparatus, e.g.
a wire guidance system embedded into the floor, serves as
a basic orientation line for the AGV to travel along.
Furthermore, Radio Frequency (RF) tags are provided along
10   the guidance apparatus, where each tag is capable of
conveying at least one of a plurality of unique RF
signals in response to electromagnetic excitation fields.
A controller on the AGV is then responsive to these RF
signals and, upon reception of an RF signal, initiates a
15   predetermined action of the AGV, such as for instance
stopping, turning or honking. The navigation system
disclosed in US 6,049,745 is suited to control the
traffic of several AGVs moving on prescribed routes
through a navigation area. Changing the route of an AGV
20   requires re-programming the RF signals produced by the RF
tags and modification of the guidance apparatus. A
flexible navigation of AGVs to changing targets is thus
not possible.

25   In view of the above-mentioned problems, it is thus the
object of the invention to provide a method and system
for accurate and flexible navigating in various types of
navigation scenarios.

30   To solve the object of the invention, it is proposed that
a method for navigating within a navigation area, wherein
a plurality of navigation tags has been mounted at
predetermined positions within the navigation area, is

characterised in that it comprises the steps of
determining a sequence of navigation tags, which are
associated with a desired route within the navigation
area, based on said positions of the navigation tags and

5   on topographic information on the navigation area, and
navigating said route by passing navigation tags of said
sequence of navigation tags, whereby passing of a
navigation tag is acknowledged.

When a route, which comprises a start point and an end

10   point and, where appropriate, one or more intermediate
points, is defined by a user, the first navigation tag,
the position of which is closest to the position of the
start point is identified and then represents the first
navigation tag in said sequence of navigation tags. Based

15   on an intelligent routing method, then the route to the
end point via the intermediate points is determined,
where the navigation tags the position of which has the
smallest Euclidean distance to this route or the
navigation tags that are located at points of the route

20   where a change of direction is necessary, are
consecutively entered into said sequence of navigation
tags. The user then, tag by tag, processes the sequence
of navigation tags by physically passing each navigation
tag. The passing of a navigation tag is acknowledged, and

25   each acknowledged tag may be erased from the sequence,
until the end point of the route is reached. Each entry
in the sequence of navigation tags at least contains any
kind of identification of the navigation tag, e.g. a
number, a position or a colour code, so that passing of

30   each navigation tag can be uniquely acknowledged. Further
information on how to reach the next navigation tag may
be included in each entry of the sequence of navigation
tags as well, e.g. the direction or distance to the next

navigation tag. Instead of navigating said route tag-by-
tag, it is also possible to skip navigation tags, i.e.
not necessarily all navigation tags of said sequence of
navigation tags have to be consecutively passed. Skipping

5   of navigation tags (roaming of the user) may for instance
be noticed when passing of the next navigation tag is
acknowledged.

A first preferred embodiment of a method of the present

10   invention is characterised in that said positions are
stored in a mobile navigation unit, that said mobile
navigation unit further stores topographic information on
the navigation area and that said sequence of navigation
tags is determined by said mobile navigation unit based

15   on said stored positions and said topographic
information.

A second preferred embodiment of a method of the present
invention is characterised in that said positions are

20   stored in a host unit, that said host unit further stores
topographic information on the navigation area, that said
stored positions and topographic information are
transferred to and stored in a mobile navigation unit,
and that said sequence of navigation tags is determined

25   by said mobile navigation unit based on said stored
positions and said topographic information.

According to the second preferred embodiment of a method
of the invention, said transfer of the stored positions

30   and topographic information may be performed by means of
a wired link between host unit and mobile navigation unit
or by means of a wireless link.

A third preferred embodiment of a method of the present
invention is characterised in that said positions are
stored in a host unit, that said host unit further stores
5   topographic information on the navigation area, that said
sequence of navigation tags is determined by said host
unit based on said stored positions and said topographic
information, and that said sequence of navigation tags is
transferred to a mobile navigation unit from the host
10   unit.

According to the third preferred embodiment of a method
of the invention, said sequence of navigation tags may be
transferred to said mobile navigation unit from said host
15   unit at once, or in parts, whereby transfer of each part
of said sequence of navigation tags is initiated by said
acknowledgement of the passing of a navigation tag. In
the first case, said sequence of navigation tags is also
stored in the mobile navigation unit upon receipt,
20   whereas in the second case, storage of each part of the
sequence of navigation tags may be optional.

According to the third preferred embodiment of a method
of the invention, said transfer of the sequence of
25   navigation tags may be performed by means of a wired link
between host unit and mobile navigation unit or by means
of a wireless link.

According to the methods of the present invention, it is
30   advantageous that said mobile navigation unit is capable
of indicating information on the navigation tag that
should be passed next.

Information on the navigation tag that should be passed
next advantageously comprises the direction and/or
distance to the next navigation tag, and/or an identifier
5   of the next navigation tag.

Said identifier may be a colour and/or a number and/or a
symbol.

10   Said information on the navigation tag that should be
passed next is preferably indicated optically and/or
acoustically and/or haptically.

According to the methods of the present invention, said
15   acknowledgement of the passing of a navigation tag may be
performed automatically or manually and may update said
indication of the information on the navigation tag that
should be passed next.

20   An automatic acknowledgement may be based on a wireless
link between mobile navigation unit and navigation tag,
such as a radio or optic link.

A manual acknowledgement may be based on a wired
25   connection between mobile navigation unit and navigation
tag, or by interaction between the user of the mobile
navigation unit and the mobile navigation unit.

According to the methods of the present invention, it is
30   further advantageous that the navigation tag itself is
capable of storing information and that said information
is transferred to said mobile navigation unit when the
navigation tag is passed.

Such information may comprise the position of the
navigation tag and/or information on the location within
the navigation area where the navigation tag is mounted.

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According to the methods of the present invention, the
position of the navigation tags are preferably determined
by means of a terrestrial or satellite-based positioning
system such as the Global Positioning System (GPS) and/or
10   by maps and/or plans of the navigation area.

The mobile navigation unit may be integrated into or
compatible to a mobile device such as a mobile phone, a
personal digital assistant or a GPS receiver.

15

According to the second preferred embodiment of a method
of the invention, it is advantageous that the mobile
navigation unit is integrated into or compatible to a
mobile phone associated with a mobile radio system, that
20   the core network of the mobile radio system can gain
access to said host system, and that said stored
positions and topographic information is transferred to
the mobile navigation unit via the air interface of the
mobile radio system.

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According to the third preferred embodiment of a method
of the invention, it is advantageous that the mobile
navigation unit is integrated into or compatible to a
mobile phone associated with a mobile radio system, that
30   the core network of the mobile radio system can gain
access to said host system, and that said sequence of
navigation tags is transferred to the mobile navigation
unit via the air interface of the mobile radio system.

The object of the invention is further solved by a system
for navigating in a navigation area, wherein a plurality
of navigation tags has been mounted at predetermined

5   positions within said navigation area, characterised in
that the system comprises means for determining a
sequence of navigation tags, which are associated with a
desired route within the navigation area, based on said
positions of the navigation tags and on topographic

10   information on the navigation area; and means for
acknowledging the passing of a navigation tag, when said
route is navigated by passing navigation tags of said
sequence of navigation tags.

15   A first preferred embodiment of a system of the present
invention is characterised in that said positions are
stored in a storage unit that is comprised in a mobile
navigation unit, that said mobile unit further comprises
a storage unit with topographic information on the

20   navigation area and that said mobile navigation unit
further comprises means for determining the sequence of
navigation tags based. on the contents of both storage
units.

25   A second preferred embodiment of a system of the present
invention is characterised in that said positions are
stored in a host unit, that said host unit further
comprises a storage unit with topographic information on
the navigation area, that said host unit and a mobile

30   navigation unit comprise means for transferring said
stored positions and topographic information from the
host unit to the mobile navigation unit, that said mobile

navigation unit further comprises means for storing said
positions and topographic information, and
and that said mobile navigation unit further comprises
means for determining the sequence of navigation tags
5   based on said stored positions and said stored
topographic information.

According to the second preferred embodiment of a system
of the present invention, said means for transferring
10 said stored positions and topographic information are
advantageously capable of establishing a wired link
between host unit and mobile navigation unit or a
wireless link.

15 A third preferred embodiment of a system of the present
invention is characterised in that said positions are
stored in a storage unit that is comprised in a host
unit, that said host unit further comprises a storage
unit with topographic information on the navigation area,
20 that said host unit further comprises means for
determining the sequence of navigation tags based on the
contents of both storage units, and that said host unit
and said mobile navigation unit comprise means for
transferring said sequence of navigation tags from the
25 host unit to the mobile navigation unit.

According to the third preferred embodiment of a system
of the present invention, said means for transferring
said sequence of navigation tags are advantageously
30 capable of establishing a wired link between host unit
and mobile navigation unit or a wireless link.

Said mobile navigation unit preferably comprises means
for indicating information on the navigation tag that
should be passed next.

5   Said means for indicating information on the navigation
tag that should be passed next advantageously comprises
optic and/or acoustic and/or haptic means.

It is further preferred that means are provided for
10   automatic or manual acknowledgement of the passing of a
navigation tag and that means are provided to update said
indication of the information on the navigation tag that
should be passed next.

15   Said automatic acknowledgement is preferably based on a
wireless link between mobile navigation unit and
navigation tag, such as a radio or optic link.

Said manual acknowledgement is preferably based on a
20   wired connection between mobile navigation unit and
navigation tag, or on means enabling an interaction
between the user of the mobile navigation unit and the
mobile navigation unit.

25   According to the systems of the present invention, it is
further preferred that the navigation tag itself
comprises means for storing information and that both
navigation tag and mobile navigation unit comprise means
for transferring said information from the navigation tag
30   to the mobile navigation unit when the navigation tag is
passed.

The mobile navigation unit may be integrated into a mobile device such as a mobile phone, a personal digital assistant or a GPS receiver.

5 According to the second preferred embodiment of a system of the present invention, it is preferred that the mobile navigation unit is integrated into or compatible to a mobile phone associated with a mobile radio system, that the core network of the mobile radio system can gain

10 access to said host system, and that said stored positions and topographic information are transferred to the mobile navigation unit via the air interface of the mobile radio system.

15 According to the third preferred embodiment of a system of the present invention, it is preferred that the mobile navigation unit is integrated into or compatible to a mobile phone associated with a mobile radio system, that the core network of the mobile radio system can gain

20 access to said host system, and that said sequence of navigation tags is transferred to the mobile navigation unit via the air interface of the mobile radio system.

Furthermore, the object of the invention is solved by a

25 computer program product directly loadable into the internal memory of a digital computer, comprising software code portions for performing the steps of any of the aforementioned methods according to the present invention when said product is run on a computer.

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These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. In the figures show:

Fig. 1:   a schematic view of a first embodiment of
               the present invention,

5   Fig. 2:   a schematic view of a second embodiment of
               the present invention, and

Fig. 3:   a schematic view of a third embodiment of
               the present invention.

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Fig. 1 depicts a schematic view of a first embodiment of
the present invention. During installation of the
navigation system, a plurality of navigation tags 1 is
mounted at predetermined positions within a navigation

15 area 2, in this case a building floor. The exact position
of each of said navigation tags 1 is determined by a
navigation tag position determination unit 5, based on
the geographic coordinates as output by a GPS receiver 3
or based on topography information as output from a

20 topography determination unit 4. Such a topography
determination unit may represent a means that digitizes a
map or a floor plan, if it is not already available as
digital plan, or converts a digital topography format.
The step of determining the exact positions of the

25 navigation tags 1 also comprises the step of assigning
each navigation tag a unique identifier within the
navigation system, and, to furnish each navigation tag
with electromagnetically, magnetically or optically
readable further information such as its accurate

30 position or its number.

According to the first embodiment of the invention, the
exact positions of the navigation tags 1 as determined by

the navigation tag position determination unit 5 and the
digitised topography information as output by the
topography determination unit are then transferred to the
mobile navigation unit 6. The mobile navigation unit thus
5   comprises storage units for the navigation tag positions
7 and the topography information 8. Said storage units 7
and 8 can be written to via interface units 9 and 10,
respectively. The combination of interface unit 9 and
storage unit 7 then represents an EEPROM, a flash memory
10   or any other kind of writable or even re-writable storage
medium with access means. However, frequent re-
programming of the storage units 7 and 8 is not intended,
and as a low cost variant, only programming the storage
units 7 and 8 once is envisaged in this first embodiment
15   of the invention, causing the mobile navigation unit 6 to
be bound to use within the specific navigation area 2.

The mobile navigation unit 6 further comprises a
microprocessor 11 that is capable of receiving route
20   inputs from an input unit 12, performing routing tasks
based on said route inputs, on the contents of the
navigation tag position storage unit 7 and the topography
storage unit 8, receiving and processing acknowledgements
from an RF unit 13, and operating a display controller
25   14. When the user of the mobile navigation unit 6 enters
a start position, either by entering a navigation tag
number, geographical coordinates, a name of a room or a
room number by means of a keypad, or by touching a
desired point on the display 16 of the mobile navigation
30   unit 6, or by any further external input such as barcode
scanner or similar, this start position is stored in the
microprocessor 11. A desired end position and
intermediate positions on the route can be entered via

the input unit 12 as well. When entering of the route
points is finished, the microprocessor 11 determines a
suited route within the navigation area 2 that connects
all entered points, and especially considers which of the

5   navigation tags should be passed when following the
determined route from the start position to the end
position. As a result, the microprocessor 11 then
generates a sequence of navigation tags 1 that should be
passed when navigating the route from the start position

10   to the end position via the intermediate positions. Each
entry in said sequence may define a unique identifier of
a tag, such as a navigation tag number, or the unique
geographic position of the tag. Further navigation
information, such as how to navigate from the present

15   navigation tag to the next, may be included in the
entries within the sequence of navigation tags as well.
The generation of the sequence of navigation tags 1 by
the microprocessor 11 is based on the information
contained in the navigation tag position storage unit 7

20   and the topography storage unit 8, to which the
microprocessor 11 has access, and on the routing
algorithm stored in the microprocessor itself or in its
main memory.

25   After generation of said sequence of navigation tags 1
that should be passed when navigating the route, the
microprocessor waits for the acknowledgement of the first
navigation tag 1 of said sequence of navigation tags.
Such an acknowledgement is generated by the RF unit 13,

30   which is connected to an antenna 15. If the navigation
tags 1 are embodied as transponders, the RF unit
possesses the capability of activating the transponders
when a certain distance between RF unit 13 and navigation

tag 1 is fallen below, so that information programmed

into these transponders can be read out by the RF unit

13. E.g, a unique identifier such as a number, or the

geographical position of the navigation tag 1 that was

5   programmed into the tag during the installation of the

navigation system, can be read out. It is further

possible to read out more information from the navigation

tag 1, such as information on the location where the tag

has been placed, which may be of interest in museums,

10   exhibitions or in public places. Furthermore, the

exchange of information between the RF unit 13 and the

navigation tag can be achieved by an optical link, such

as e.g. a barcode scanner, or magnetically. Even a wired

connection is possible, when the user of the mobile

15   navigation unit 6 connects the unit to each navigation

tag 1 by means of a cable. The only demand is that the

exchange of information is robust and limited to short

range, to ensure accurate navigation and to limit the

power consumption of the mobile navigation unit.

20   Information read out from the navigation tags is

signalled to the microprocessor 11 by the RF unit 13 as

an acknowledgement of said navigation tag. The

microprocessor thus is informed that a navigation tag has

been passed and then waits for the acknowledgement of the

25   next navigation tag of the sequence of navigation tags.

Each time an acknowledgement is received, the

microprocessor 11, via the display control unit 14,

changes the information depicted on the display 16, so

that the user of the mobile navigation unit is provided

30   with new information on how to proceed with the route.

Such information on the display 16 may comprise the

number of the next navigation tag 1, its colour, if

colour-coded navigation tags 1 are deployed, or, if a

gyroscopic compass is included within the mobile
navigation unit 6 under the control of the microprocessor
11, a direction towards the next navigation tag 1. Said
information is generated in the context of the generation

5   of said sequence of navigation tags 1 by the
microprocessor 11. Alternatively, in a low-cost
embodiment of the mobile navigation unit, the
acknowledgements are not provided by the RF unit 13, but
by the user of the mobile navigation unit 6 itself. The

10   RF unit then can be saved, and the navigation tags 1 do
not have to be embodied as transponders. It is then
sufficient to use signs as navigation tags, where when
reaching a sign, the user acknowledges passing of the
sign via the input unit 12, and the number and/or

15   directions to the next sign are displayed.

The microprocessor 11 also possesses the capability of
error handling and error recovery, such as e.g.
recognising that navigation tags have not been passed on

20   the route or that the user is roaming, i.e. significantly
deviating from the originally desired route.

Fig. 2 depicts a schematic view of a second preferred
embodiment according to the present invention. In

25   contrast to the first embodiment of Fig. 1, a host unit
17 is provided, which comprises a navigation tag position
storage unit 18 and a topography storage unit 19. During
the installation of the navigation system, the exact
positions of the navigation tags 1 as determined by the

30   navigation tag position determination unit 5 are loaded
into the navigation tag position storage unit 18, and the
output of the topography determination unit 4 is loaded
into the topography storage unit 19. The host unit

further comprises interfaces 20 and 21, which, in
combination with the interfaces 9 and 10 as provided in
the mobile navigation unit 6, allow to transfer the
contents of the navigation tag position storage unit 18

5   and of the topography storage unit 19 into the navigation
tag position storage unit 7 and the topography storage
unit 8 of the mobile navigation unit 6. In contrast to
the first embodiment, in the present second embodiment,
frequent re-writing of the storage units 7 and 8 of the

10   mobile navigation unit is intended, and the storage units
are specified accordingly. With the entire information
required for navigating a route within the navigation
scenario depending on the contents of the navigation tag
position storage units 18/7 and of the topography storage

15   units 19/8, the mobile navigation unit 6 becomes
independent of the navigation area 2 and can be used
equally well in different navigation areas. When a mobile
navigation unit 6 is to be used in a new navigation area
2, simply the navigation tag positions and the topography

20   information are transferred from the storage units 18 and
19 of the host unit to the storage units 7 and 8 of the
mobile navigation unit 6, respectively. The data
transfer, which is controlled by the interface units 20
and 21 and 9 and 10, can be based on a wired or wireless

25   connection, such as an infra-red link or a radio link,
e.g. a Bluetooth connection. The host unit then will be
provided at a central location in the navigation area 2,
for instance a reception desk in a hospital. After data
transfer, the navigation can be managed by the mobile

30   navigation unit itself, as already described for the
first embodiment of the invention.

If the mobile navigation unit is included in a mobile
phone, the storage units 18 and 19 of the host unit 17
can be made accessible to the core network of the mobile
radio system that covers the mobile phone via an intra-
5   or the internet. The data transfer between the storage
units 18 and 19 of the host unit to the storage units 7
and 8 of the mobile navigation unit then is performed
based on a standard data call between the mobile phone
and the core network, e.g. a GPRS connection. It is thus
10 possible to navigate in different navigation scenarios 2
with the same mobile phone.

Fig. 3 finally depicts a schematic view of a third
preferred embodiment according to the present invention.
15 In contrast to the second embodiment of the invention as
depicted in Fig. 2, the third embodiment contains a host
unit 17 that. comprises storage units for the navigation
tag positions 18 and the topography information 19, and
additionally a microprocessor 22 that is capable of
20 receiving route inputs from an input unit 23 and of
performing routing tasks based on said input routes, on
the navigation tag position storage unit 18 and on the
topography storage unit 19. The microprocessor 22 thus
determines a sequence of navigation tags that have to be
25 passed when navigating a desired route within the
navigation area 2. The microprocessor 22 is connected to
an interface unit 24, which corresponds to an interface
unit 25 in the mobile navigation unit 6. Between both
interface units 24 and 25, a wired or wireless connection
30 can be established to transfer the sequence of navigation
tags as determined by the microprocessor 22 from the host
unit 17 to the mobile navigation unit 6. Within the
mobile navigation unit 6, the interface unit 25 forwards

a received sequence of navigation tags to a
microprocessor 26 of the mobile navigation unit 6, where
it is stored in the internal memory of the microprocessor
or in an additional storage device provided in the mobile

5   navigation unit 6. In the present third embodiment of
the invention, the microprocessor 26, as compared to the
microprocessor 11 of the first and second embodiment, has
limited complexity and is only capable of operating the
display controller 14 and receiving acknowledgements from

10   the RF unit 13. However, error handling and recovery
procedures are executed by the microprocessor 26 as well
in order to manage skipped navigation tags and roaming of
the user.
Note that, instead of transferring the complete sequence

15   of navigation tags at once, it is also possible that
after acknowledgement of a passed navigation tag, one or
several new entries in the sequence of navigation tags
are transferred from the host unit 17 to the mobile
navigation unit 6, possibly together with further

20   information on the location where the currently passed
navigation tag is mounted.

As in the second embodiment of the invention, if the
mobile navigation unit 6 is part of a mobile phone, and

25   the navigation tag positions and the topography
information are accessible to the core network of the
mobile radio network that covers the mobile phone via an
intra- or the internet, the sequence of navigation tags
as determined by the microprocessor 22 of the host unit

30   17 can be transferred to the mobile navigation unit 6 via
a data call, e.g. via a GPRS connection. Due to the fact
that the entire calculation of the route and the
determination of the sequence of navigation tags is

performed by the host unit, only minor complexity is required to implement the functionality of the mobile navigation unit 6 within the mobile phone. This especially holds for the case when the RF unit 13 is

5   spared and passed navigation tags are acknowledged by the user himself, as described before. As in the second embodiment of the present invention, the mobile phone is still independent of the specific navigation area 2.

10   The invention has been described above by means of preferred embodiments. It should be noted that there are alternative ways and variations which are obvious to a skilled person in the art and can be implemented without deviating from the scope and spirit of the appended

15   claims, e.g. the storage units in the mobile navigation unit may be included into the memory of the microprocessor, or the interface units between the mobile navigation unit and the host unit may be combined into one single interface unit.

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